SULFATE-RICH PLAYAS: A MICROBIAL HABITAT AND TERRESTRIAL ANALOG TO MARTIAN PLAYAS.

M. Glamoclija[1], A. Steele[2], V. Starke[2], M. Zeidan[1], S. Potochniak[1] and I. H. Widanagamage[1], [1]Rutgers University-Newark, 101 Warren St, Newark, NJ 07102 (email: m.glamoclija@rutgers.edu), [2]Carnegie Institution of Washington, 5251 Broad Branch Rd, Washington, DC 20015.

Introduction: Martian surface-exposed sequences of sulfate-rich sedimentary formations are particularly interesting as they emphasize the importance of surface and near-surface aqueous processes during the planet's history. Playa/playa lake systems have received particular attention as the presence of Noachian/early Hesperian sulfate-rich deposits have been identified by the Mars Exploration Rover Opportunity at Meridiani Planum [1, 2] and by Mars Reconnaissance Orbiter (MRO) in sedimentary sequences within Gale crater [3, 4]. We are investigating playa systems from the White Sands National Monument (WSNM) in New Mexico as an excellent model system to study sulfate-rich evaporitic sequences that could help better understanding environmental parameters of playas, their potential for preservation of organics and exploration of biosignatures and habitability parameters that may be relevant for inferred playa deposits on Mars

Alkali Flat Settings: The geological history of White Sands' Alkali Flat includes sedimentary sequences that include fresh and saline water deposits and final transition to playa setting. The lacustrine sediments of pluvial Pleistocene Lake Otero include facies that suggest periodic contribution of relatively fresh water into an otherwise saline lake during its highstand [5, 6]. About 9,000 to 12,000 yrs ago, the onset of significant regional aridity caused evaporation and deflation of Lake Otero [7]. Most of the fresh water strata were removed by the initial onset of aridity. The subsequent erosion and continuing aridity through the Holocene created several erosional escarpments into playa lake deposits [7, 8].

We have sampled shallow depth profiles (1.5 m) along the transect over the largest modern playa (Lake Lucero, Figure 2.) and a depth profile of one or the erosional escarpments to identify potential mineral biosignatures, to look at the specific location within the deposits for microbial habitats and to try to probe a few thousands years old deposits for fossil signatures.

Results and Discussion: In our previous field campaigns near surface sediments from dune field had shown the presence of biofilm, and at some of the locations the surface had vesicular crust over green biofilm. However, this field sampling revealed no obvious presence of biofilm or any structures within the sediments. The main characteristic of each sampling site was that top samples had very dry surface and the bottom samples are usually sampled at the groundwater table or near it. In this way the sampled profile includes samples from groundwater table (or capillary fringe) to the surface, which is the most geochemically active zone in the desert environment.

Bruker D8 Avance Eco with Cu-Ka radiation source and a LynxEye XE detector X-Ray Diffractometer (XRD) was used to identify major mineral phases in the samples. The surface samples of the playas are mainly composed of gypsum ($CaSO_4x2H_2O$) and mirabilite ($Na_2(SO_4)x10H_2O$) or thenardite ($Na_2(SO_4)$), some quartz (SiO_2) and halite (NaCl). Below the surface only gypsum and occasional halite were detected using XRD.

Hitachi S-4800 Scanning Electron Microscope with Energy Dispersive X-Ray Spectroscopy (SEM-EDS) was used to analyze morphology and composition of the samples at high resolution. Analytical conditions for SEM observations of iridium coated samples were standard high vacuum mode (1.9 x 10^{-4} Pa) with 20 kV beam. Each sample was divided into 3 subsamples air dried, coated and analyzed. SEM analysis revealed occasional presence of biological morphologies. Most of morphologies were found within the deposits of erosional escarpment and in the bottommost samples of the depth profiles (see Figure 1 for en example of the filaments found in the bottom sample of the LL3 site)

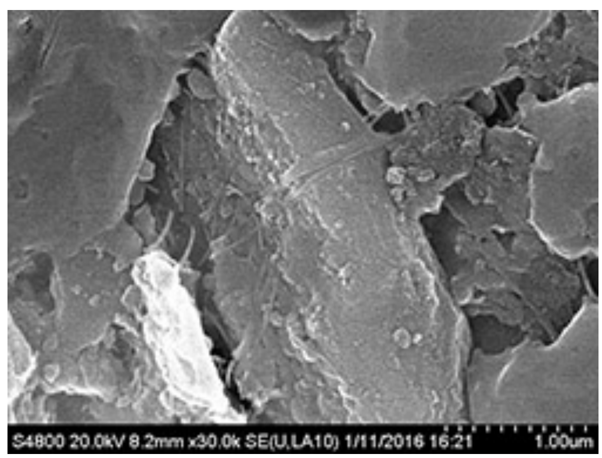

Figure 1. SEM micrograph of the playa sample from 1m depth showing very thin filament cluster wrapped around gypsum and halite minerals. Scale is 1 μm.

The EDS analyses revealed high diversity of mineral precipitates within all of the samples. Interestingly, all of the samples (except surface samples) contained celestine. We have found in our previous study of surface dune field samples [9] that celestine was found only within thick biofilm at paleodunes site, which misled us to believe it was a potentially important as a mineral precipitated in microbial presence. However, now it is clear that celestine is present in all of the wet/moist samples and as they dry it gets blown away from the playa surface. We have found a diversity of magnesium precipitates through out the samples(Ca-Mg carbonates, hexahydrite ($MgCl_2xH2O$) or magnesium chlorite, epsomite ($MgSO_4x7H_2O$) etc.) which indicates that groundwater is likely Mg-rich. The high halite and mirabilite and lesser glauberite and epsomite presence points out the high-salinity content that microbes living here have to be able to overcome. The samples have further shown presence of clays, calcium carbonates, occasional presence of phosphor and potassium and carbon compound within salt precipitates. The low detection of microbial morphologies within these samples may be contributed to low bioload and the fact that hypersaline microbes often become trapped in salt during the sample preparation. Further DNA analyses and microscopy will help to clarify this observation. Undergoing ion and nutrient analyses will help us understand major geochemical processes within upper meter of Alkali Flat playa deposits and reveal compounds that are potentially available for microbes to metabolize.

References: [1] Grotzinger J.P. et al. (2005) Earth *Planet. Sci. Lett. 240,* 11-72. [2] Andrews-Hanna J.C. et al. (2010) *JGR,* doi:10.1029/JE003485 [3] Milliken R.E. et al (2010) *GRL,* doi:10.1029/2009GL041870 [4] Thomson B.J. (2011) *Icarus, 214,* 413-432. [5] Fryberger S.G. (2000) http://www.nps.gov/whsa/Geology%20of%20White%20Sands/GeoHome.html. [6] Allen B.D. et al. (2009) *New Mexico Geol, 31,* 19-25. [7] Langford R.P. (2003) *Quaternar. Intl. 104,* 31-39. [8] Langford R.P. (2002) *Proc. ICAR5/GCTE-SEN Conf.,* 400. [9] Glamoclija M. et al. (2012) *Geomicrobiol. J. 29*,733-751.

Acknowledgements: This research is supported by ASTEP NNX12AP776. We are particularly grateful to D. Bustos and K. Wirtz from NPS WSNM for their precious help during the field season..

Figure 2. One of the sampling locations at Alkali Flat at White Sands National Monument, New Mexico.